legend varies over time. A prime example is an automat which serves customers in several languages. Another example is a multi-function remote controller, wherein the keypad legend varies depending on which set or piece of equipment is being controlled. A residual problem in touch screen interfaces is that the act of touching per se does not provide the user with any feedback as to whether the key press was accepted or not. This is why prior art touch screen interfaces are normally provided with a separate feedback system which may employ visual or aural information. But for the reasons stated above, visual feedback is not always satisfactory and aural feedback has its own problems, such as difficulty of detection in noisy surroundings.

[0017] Accordingly, some embodiments of the invention address the above-described feedback problems by providing electro-sensory feedback indicating whether or not a touch-sensitive area is currently being activated.

[0018] In order to provide the electro-sensory stimulus which provides the user with an indication of the layout of the touch-sensitive areas, the touch screen interface according to the invention can be implemented by means of a capacitive electro-sensory interface as described in commonly assigned patent applications FI20075651, filed Sep. 18, 2007, or U.S. 60/960899, filed Oct. 18, 2007, both titled "Sensory interface". Later in this document, the acronym "CEI" refers to a capacitive electro-sensory interface.

[0019] The electro-sensory stimulus generator is preferably dimensioned such that the electrosensory sensation is produced independently of relative motion between the user's body member, such as a finger, and the insulated electrode(s). Creation of the electrosensory sensation without finger movement provides the benefit that the user's finger can feel an underlying area, to which a function is assigned. Some prior art techniques require finger movement to create the electrosensory sensation. For instance, reference document 1 (Yamamoto) discloses a technique in which a variable electric field is used to modulate the frictional force between the finger and the underlying surface. This means that the inventive technique can provide an indication when the user's finger is (stationary) on top of a predefined area, whereas the prior art, as exemplified by Yamamoto, can only indicate when the user's finger is moving over the predefined area. The ability to provide an indication of a stationary finger on top of a predefined area brings about the benefit that the user may select the function assigned to the predefined area, and then let their finger rest in place to wait for an acknowledgment that the user's selection of function has been accepted. The acknowledgment may be provided by varying the electrosensory stimulus, while the user's finger is stationary on top of the predefined area.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] In the following the invention will be described in greater detail by means of specific embodiments with reference to the attached drawings, in which

[0021] FIG. **1** illustrates the operating principle of a capacitive electro-sensory interface ("CEI");

[0022] FIG. **2** illustrates an embodiment of the CEI;

[0023] FIG. **3** shows an enhanced embodiment with multiple independently-controllable electrodes;

[0024] FIG. **4** shows a specific implementation of the embodiment shown in FIG. **3**;

[0025] FIG. **5** is a graph which schematically illustrates the sensitivity of a test subject to sensations produced by the inventive capacitive electrosensory interface at various frequencies; and

[0026] FIG. **6** is a graph which further clarifies the operating principle of the CEI;

[0027] FIGS. **7**A and **7**B show an implementation of the CEI wherein the strength of the capacitive coupling is adjusted by electrode movement;

[0028] FIG. **8** shows an implementation of the CEI wherein the charges of different electrodes have opposite signs;

[0029] FIG. **9** shows an implementation of the CEI wherein a group of electrodes are organized in the form of a matrix;

[0030] FIG. **10** illustrates distribution of an electric field-generating potential in capacitive couplings when the apparatus is grounded;

[0031] FIG. **11** illustrates distribution of an electric field-generating potential in capacitive couplings when the apparatus is floating (not grounded);

[0032] FIG. **12** illustrates distribution of an electric field-generating potential in capacitive couplings when the apparatus is floating and the user is sufficiently close to the apparatus and capacitively grounded to the ground (reference) potential of the apparatus;

[0033] FIG. **13** shows an arrangement wherein capacitive couplings are utilized to detect touching;

[0034] FIGS. **14** and **15** illustrate embodiments in which a single electrode and temporal variations in the intensity of the electro-sensory stimulus can be used to create illusions of a textured touch screen surface;

[0035] FIG. **16**A shows an embodiment of the invention in which the electrode(s) for the tactile output section are positioned between the touch input section and the display layer; and

[0036] FIG. **16**B shows an embodiment of the invention in which the electrode(s) for the tactile output section are positioned on top of a touch input section, which in turn is positioned on top of a display layer.

DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

[0037] The embodiments described in the following relate to the operation and implementation of a capacitive electro-sensory interface ("CEI") which can be employed in the inventive touch screen interface.

[0038] FIG. **1** illustrates the operating principle of the CEI. Reference numeral **100** denotes a high-voltage amplifier. The output of the high-voltage amplifier **100**, denoted OUT, is coupled to an electrode **106** which is insulated against galvanic contact by an insulator **108** which comprises at least one insulation layer or member. Reference numeral **120** generally denotes a body member to be stimulated, such as a human finger. Human skin, which is denoted by reference numeral **121**, is a relatively good insulator when dry, but the CEI provides a relatively good capacitive coupling between the electrode **106** and the body member **120**. The capacitive coupling is virtually independent from skin conditions, such as moisture. The inventors' hypothesis is that the capacitive coupling between the electrode **106** and the body member **120** generates a pulsating Coulomb force. The pulsating Coulomb force stimulates vibration-sensitive receptors, mainly those called Pacinian corpuscles which reside under the outermost layer of skin in the ipodermis **121**. The Pacinian cor-